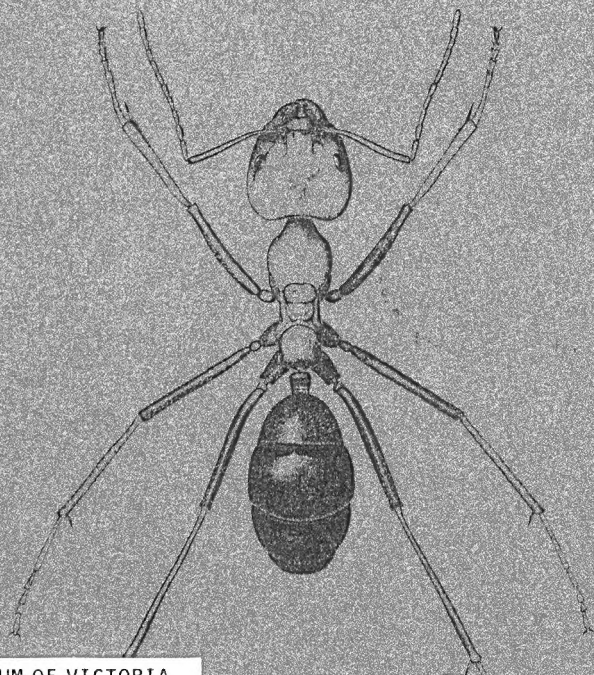


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Cover: This undescribed species of Bombyliidae of the genus *Docidomyia* is from the Goldfields Region of Western Australia. The genus belongs to the subfamily Tomomyzinae, and has closest relatives in southern Africa and North America. Adults feed on nectar and pollen and the larvae are presumably parasitoids, as are most other Bombyliidae, although nothing is known of the life history of this subfamily throughout the world. Illustration by David Yeates.

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**A NEW GENUS AND SPECIES OF STENOLOPHINA
(COLEOPTERA: CARABIDAE: HARPALINI)
FROM NEW ZEALAND**

B.P. MOORE

CSIRO, Division of Entomology, GPO Box 1700, Canberra, ACT 2601

Abstract

Haplanister crypticus gen. et sp. nov. is described from various localities in New Zealand, where it is now widespread. Notwithstanding its relatively recent discovery and its current abundance in certain pastoral districts, it is known also from natural habitats. It remains unclear whether the species is a native that is now proliferating in artificial environments or an introduced alien that has not yet been recognised in its country of origin.

Introduction

Within the last quarter-century, a small winged harpaline carabid that previously was undetected in the New Zealand fauna has become increasingly common in pastoral districts of that country. This led local entomologists to suspect that the species could be another case of establishment of a recently imported alien and specimens therefore were submitted to me for identification. However, the genus and species are currently unknown to me from Australia and I have never come across them in any world-based collection that I have examined; nor are they covered by Noonan's (1976) revision of world higher taxa of Harpalini. Moreover, the species in question has since been discovered in more remote and little modified regions of New Zealand, including two small off-shore islands. Thus it is still unclear whether we are dealing with a native insect that has adapted recently to man-made agrarian environments, or an introduced alien that has not been detected yet in its native country.

***Haplanister* gen. nov.**

(Figs 1-5)

Type species: *Haplanister crypticus* sp. nov.

A genus of Carabidae: Harpalini: Stenolophina with the following character states.

Body small; antennae short, segments 3-11 pubescent; labial palpi bisetose; paraglossae (Fig. 2, p) short, not meeting in front of ligula; mentum (Fig. 2, m) with a median tooth; frontal furrows deep but short; prosternum and abdominal sternites without fine pubescence; elytra with weak striae on second intervals; third intervals with one (postmedian) pore; humeral umbilical series consisting of 6 pores, the sixth widely removed from the others; posterior series of 7 pores, not widely segregated into subseries; elytral apical margins widely rounded, scarcely sinuate; tarsi glabrous above; tarsomere-1 of hind tarsi short; male foretarsi unmodified; aedeagus (Figs 4-5) small; median lobe short, well sclerotised; no well defined armature in internal sac; parameres short, subequal, the left ventral to median lobe in

repose; female stylomeres (Fig. 3) unarmed, stylomere-2 short, stout, with one apical seta.

Characters that indicate that this genus should be placed in the subtribe Stenolophina include the small body size, the bisetose labial palpi, the widely rounded elytral apical margins and the general habitus of the type species. The unmodified male foretarsi are exceptional but scattered occurrences of this kind are known within the tribe Harpalini and, in particular, in the Australian genus *Haplaner* Chaudoir (1878) of the Stenolophina.

Noonan (1976) placed *Haplaner* in his "*incertae sedis*", largely because of the simple male foretarsi in the type species (*Harpalus velox* Castelnau), the form of the male foretarsal vestiture (when present) being crucial in harpaline classification. However, an undescribed species of *Haplaner* is now known to the present author, in which these organs are biserially squamose beneath, thus confirming the suggested placement (Moore, Weir and Pyke 1987) close to *Stenolophus* Dejean. This and other new species of *Haplaner* will be dealt with in a separate paper.

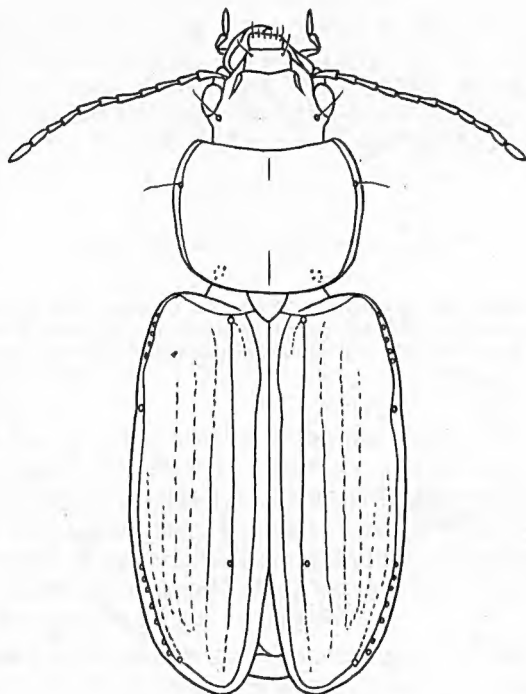
The type species of *Haplanister*, described below, certainly resembles, in general habitus, a small species of *Haplaner* (hence the choice of new generic name) but differs in the following respects: presence of a tooth in the mentum, the short, free paraglossae not completely embracing the ligula, the elytral apical umbilical series continuous, presence of weak elytral scutellary striae, tarsomere-1 of the hind tarsi short, aedeagus short and female stylomeres unarmed.

Haplanister crypticus sp. nov.

(Figs 1-5)

Types. Holotype ♂, NEW ZEALAND: HB, Hastings, ii.1979, A. Moeed, in New Zealand Arthropod Collection, Auckland (NZAC). Paratypes: 11 (both sexes), same data as holotype (NZAC and B.P. Moore Collection, Canberra); 4 (both sexes), WI, Palmerston North, ex light trap in hill country pasture, 6.xi.1974-23.iv.1975, J.M. Esson (NZAC); 1♂, 1♀, Mt Te Atuparapara, G. Ramsay (NZAC); 1♂, TK, Hump Plateau, 1220 m, Ponakai Ra., ex litter, 3.xii.1975, J.S. Dugdale (NZAC); 1♀, WO, Rukuhia, rye grass-paspalum pasture, 2.iv.1979, J.M. Barker (NZAC).

Description. Upperside microreticulate, largely dark brown; femora, apical half of tibiae, first antennomeres and maxillary palpomeres, light red; remaining appendages piceous; underside largely black. Head small, smooth, c. 0.85 mm across eyes; eyes neither large nor very prominent; palpi short; pronotum suborbicular, widest about front third; c. 1.4 x wider than head; anterior margin lightly emarginate; posterior margin subtruncate; anterior angles obtuse but subprominent; posterior angles widely rounded; sides rounded from apex to base, slightly oblique in posterior half; marginal

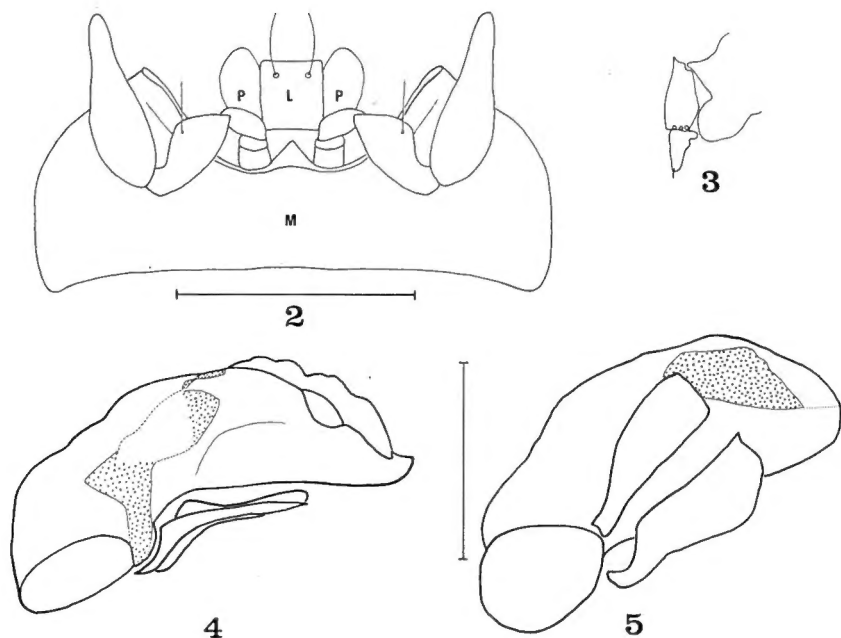


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Fig 1. *Haplanister crypticus* get. et sp. nov. paratype male; natural length = 3.9 mm.

channel narrow, evanescent on base before level of scutellum; median line and basal foveae obsolescent, latter with a few fine punctures; elytra subparallel, lightly striate on disc, striae obsolescent towards margins; intervals flat; hindwings fully developed; metepisterna very elongate, impunctate; abdominal sternites impunctate; apical sternites 4-setose in both sexes; anterior tibial spur broader in male than in female. Length 3.9-4.1 mm; maximum width 1.7-1.85 mm.

Discussion. Within the rather limited New Zealand harpaline fauna, *Haplanister crypticus* may be recognised by its small size, subcylindrical form, suborbicular pronotum, glabrous abdominal sternites and unmodified male foretarsi. It appears to be extending its range in settled areas and I have seen recently specimens from various localities in South Island (collected by R.M. Emberson), as well as from Chatham Island and Pitt Island in the off-shore Chatham Is group east of South Island.



Figs 2-5. *Haplanister crypticus* get. et sp. nov. (2), ventral mouthparts (l = ligula, m = mentum, p = paraglossa); (3), female styli, left side, ventral; (4), aedeagus in left lateral view; (5), aedeagus in ventral view. Scale lines = 0.2 mm.

Acknowledgments

I am indebted to Dr J.C. Watt (NZAC) for drawing my attention to the new species and for type material and to Dr R.M. Emberson (Lincoln University, Canterbury) for further specimens and records and for helpful comments on an early draft of the manuscript.

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THE DISTRIBUTION OF *THECLINESTHES ALBOCINCTA*
(WATERHOUSE) AND *THECLINESTHES HESPERIA*
LITTORALIS SIBATANI & GRUND, BASED ON
HERBARIUM RECORDS OF EGGS
(LEPIDOPTERA: LYCAENIDAE)

R. GRUND

9 Parkers Rd, Torrens Park, Adelaide, S.A. 5062

Abstract

The distributions of *Theclinessthes albocincta* (Waterhouse) and *Theclinessthes hesperia littoralis* Sibatani & Grund are significantly extended, based on the preservation of their eggs on dried foodplant, *Adriana* Gaudich. (Euphorbiaceae), now preserved within Australian Herbaria.

Introduction

A recent undertaking by the Adelaide Herbarium to revise the genus *Adriana* allowed an opportunity for the author to examine an Australia-wide representative collection of preserved specimens from the Perth, Adelaide, Canberra and Brisbane Herbaria, for evidence of egg laying by *T. albocincta* (Waterhouse) and *T. hesperia* Sibatani & Grund. Unfortunately, *Adriana* material from the Melbourne and Sydney Herbaria had already been returned before the author could undertake the examination.

Currently, genus *Adriana* consists of two complexes (Jessop and Toelken 1986), containing five species all of which are dioecious. The first complex, distinguished by having alternate leaves, contains *Adriana glabrata* Gaudich, *A. hookeri* (F.Muell.) Muell.-Arg., and *A. tomentosa* Gaudich. The second complex is distinguished by having opposite leaves and contains *A. klotzschii* (F.Muell.) Muell.-Arg. and *A. quadripartita* (Labill.) Gaudich.

The distribution of *A. klotzschii* and *A. quadripartita* is the coastal and near coastal sand-hills of southern Australia, including the larger offshore islands (except Bass Strait Islands) (Fig. 1), with *A. quadripartita* confined mainly to Western Australia and *A. klotzschii* solely to South Australia and Victoria. There is an inland extension of *A. klotzschii* to Eyre Peninsula and the Flinders Range and eastward into the Olary Range. *A. hookeri* occurs in the inland arid sand-hill areas of Australia, including north-west Victoria, while *A. tomentosa* occurs in the north-west of Western Australia, particularly along creeklines. *A. glabrata* also occurs along creeklines, in the northern tropical and eastern seaboard and montane areas of Australia. *Adriana* does not occur in Tasmania. The different species do not normally grow together. *Adriana* distribution in Australia (Fig. 1) was compiled from the specimens at the Adelaide Herbarium and from data base listings requested from the Alice Springs, Darwin, Melbourne and Sydney Herbaria.

Previous distributions of *T. albocincta* and *T. hesperia*, based on adult butterfly captures, were very disjointed with isolated populations recognized in south-west Western Australia, several coastal and island localities in north-

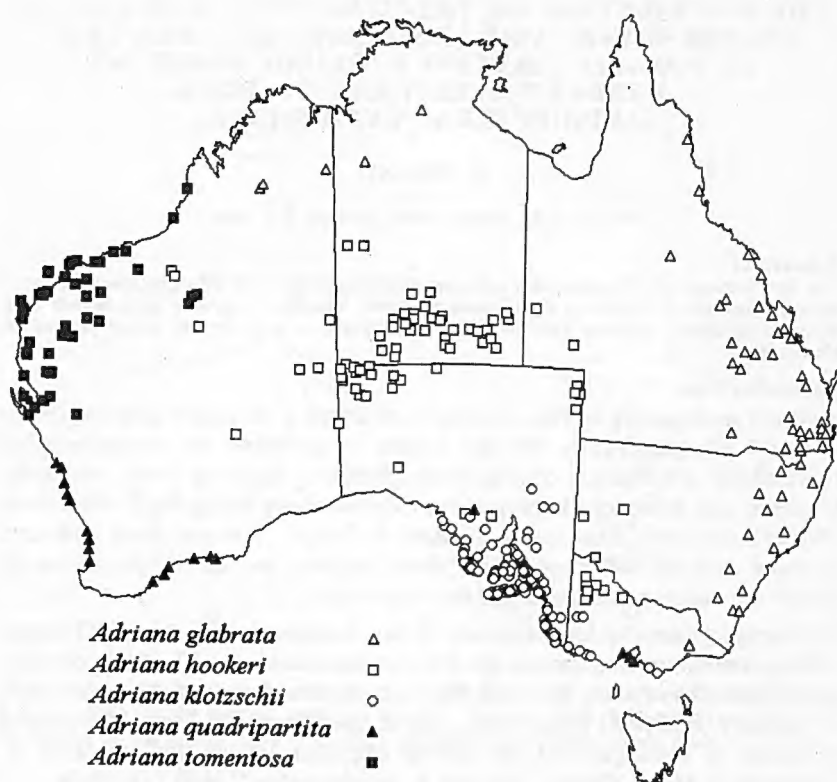


Fig. 1. Distribution of *Adriana glabrata*, *A. hookeri*, *A. klotzschii*, *A. quadripartita* and *A. tomentosa*.

west Western Australia, a couple of localities in central Australia, a broad population in southern South Australia and north-west Victoria, plus the single lectotype male from Peak Downs in Queensland (Fig. 2) (Sibatani and Grund 1978; Fisher 1978, 1985; Common and Waterhouse 1981; Field 1987, 1990; Dunn and Dunn 1991; Douglas and Braby 1992). There is also a male specimen in the Natural History Museum, London labelled 'N. Queensland' which, until now, was thought to be wrongly labelled. Life history records had shown an association of *T. albocincta* with *A. klotzschii* in coastal South Australia and with *A. hookeri* in northwest Victoria, while elsewhere adults were always captured flying near *Adriana*. *T. hesperia* had shown an association with *A. quadripartita*.

Methods and Results

Over 500 dried *Adriana* specimens were examined under binocular magnification, of which 105 specimens had indications of Lycaenid egg

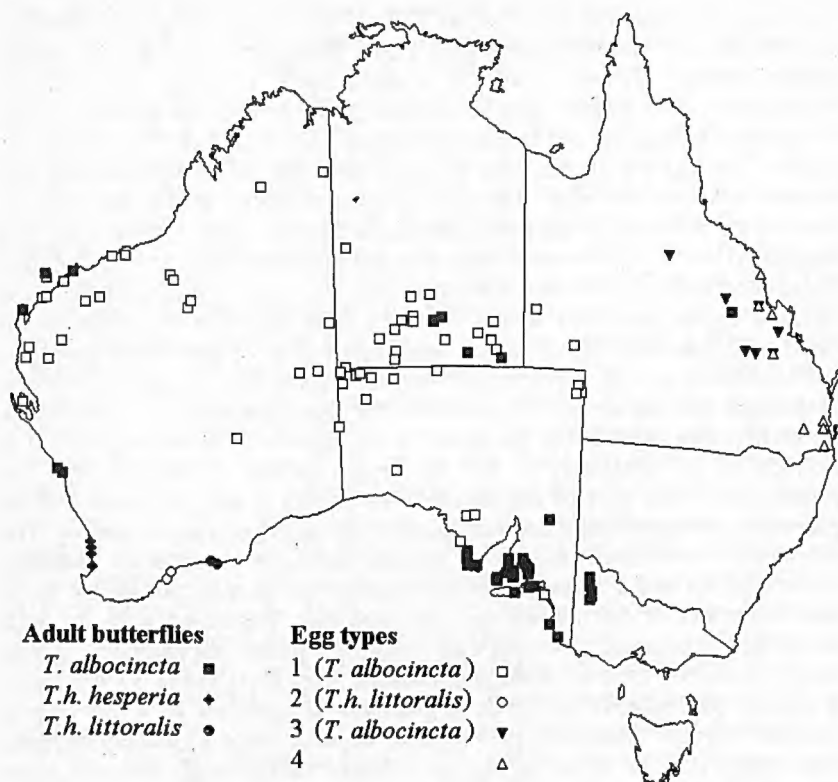


Fig. 2. Distribution of adult captures of *Theclinessthes albocincta*, *T. h. hesperia*, *T. h. littoralis* and of Egg Type 1 (*T. albocincta*), Type 2 (*T. h. littoralis*), Type 3 (*T. albocincta*), Type 4 on *Adriana* herbaria specimens.

laying. Most of the egg laying activity occurred on the male flowers (where it was sometimes abundant), but eggs were also found on the stems or beneath the leaves on both plant sexes, with subsequent larval activity having produced a scoring of the leaf surfaces. The eggs were laid singly or rarely in twos or threes. Additional evidence of larval boring into the flower buds was often recognized but not recorded in the event that the borings may have been partly due to other insect activity.

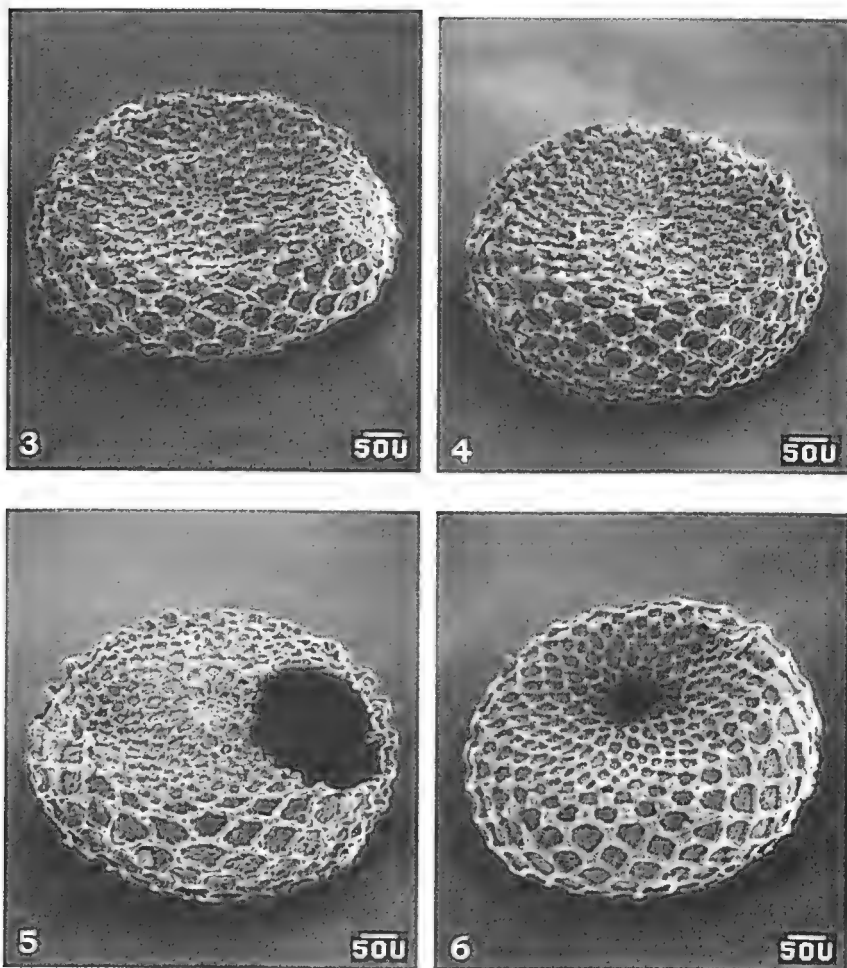
Four different egg types were recognized on the *Adriana*, all having Lycaenid character of oblate spheroid shape, the bottom flattened, the top flattened and depressed and a raised reticulated pattern of varying ornateness on the surface. The first and most common egg type is attributed directly to *T. albocincta* (as it is currently understood). It occurred on all the *Adriana* species, in Western Australia, central Australia, South Australia and north-west Victoria (Fig. 2).

This egg, illustrated in Figs 3-6, is defined by having a regular spiralling, rhomboid, reticulated pattern with thick blunt processes at the pattern intersections. These processes were usually strongly elevated but occasionally (Fig. 6) they were ill defined. Rarely, when the pattern became irregular, a hexagonal and pentagonal reticulation occurred (Fig. 5). On the sides of the egg the pattern area is quite coarse but on the flattened top it is smaller and more irregular. The intra-reticulated chorion area is dimpled. To the eye the reticulation appears fused to the chorion. Egg Type 2 (Fig. 7) is attributed to *T. h. littoralis* and was encountered only in the Albany-Esperence area of Western Australia (Fig. 2), on *A. quadripartita*. It is defined by its similarity to the first egg type but with the relief of the ornamentation markedly reduced. Egg Type 3 (Fig. 8) was found mainly in the hinterland area of the central Queensland coast (Fig. 2), on *A. glabrata*, associated with the area of occurrence of the lectotype male of *T. albocincta*. Its distribution extended to the coast in the vicinity of Rockhampton. It is defined by its similarity to the first egg type but differed in that the reticulation forms part of the chorion, the pattern is not as coarse and the processes are more consistently developed, especially on the top surface. The intra-reticulated areas are porous looking and have an apparent radiating surface which under normal light microscopy was usually not visible but it had the effect of diffracting the light and this, combined with the well developed processes, gave the egg a sugary opaline appearance. It was usually found on the male foodplant flowers. Egg Type 4 (Fig. 9) was found in coastal Queensland (Fig. 2), on *A. glabrata*. It is defined by a very coarse, irregular trigonal reticulated pattern, each trigonal shape ultimately merging with others to form larger hexagonal shapes, with strongly elevated blunt processes at the pattern intersections. The intra-reticulated area is smooth. It was usually found on the leaf undersides of male foodplants. This egg is not of typical *Theclinesstes* character, having a form very similar to *Zizina labradus* (Godart), although this butterfly is not known to use foodplants outside of the Leguminosae/Papilionoideae family. Common and Waterhouse (1981) state that *Philiris nitens nitens* (Grose-Smith) and *Arhopala micale amphis* Waterhouse use *Glochidion* spp, a plant genus related to *Adriana* in the Euphorbiaceae and therefore these eggs may belong to either of these species, although the author is not familiar with their eggs. At Banana and Yatton Creek, Egg Types 3 and 4 were found together on the same plants.

It is recognized that the above data should be used with caution (Kitching and Zalucki 1983), hence the use of (likely) as a suffix to the following egg types and the assumption is that *T. albocincta* and *T. hesperia* are restricted to *Adriana* for foodplants. The bracketed suffix to the distribution records on *Adriana* refers to the state herbarium (A=Adelaide, B=Brisbane, C=Canberra, P=Perth), its reference number and the year of sampling.

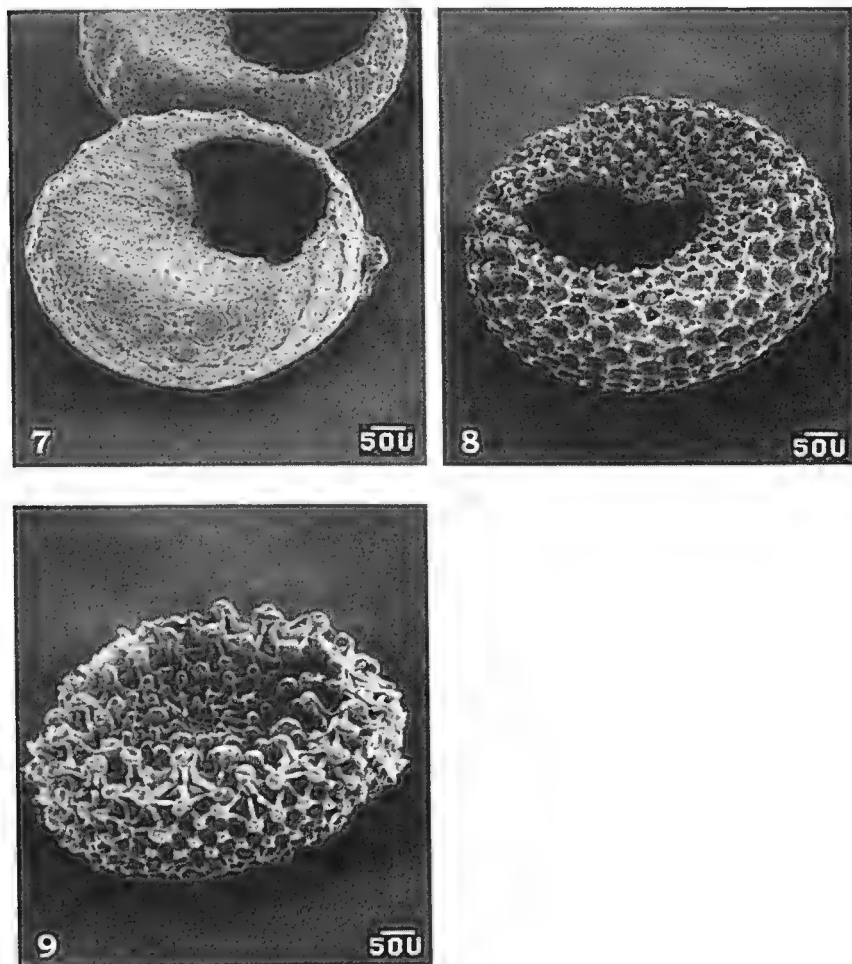
Egg records on the *Adriana* material examined:

Egg Type 1 (*T. albocincta* likely): **Western Australia** on *A. hookeri*: Sir Frederick Range (P.ex NT34904, A.97228090-1972); East of Gregory Range on Rabbit Proof Fence approx. 21°24'-121°18' (P. Royce 1887-1947); 35 km N of Lookout Rocks on R.P.F. approx. 21°38'-121°24' (P. Royce 1840-1947); between Cavanagh and Blackstone Ranges (P.George 5262-1963); 59km E Warburton Mission (C.196249-1960); 320 km NE Kalgoorlie, Victoria Desert Camp 54 (Elder Expedition) (A.96832164-1891); on *A. tomentosa*: Peron Peninsula (P. Blackall 4662-1940); Minilya (A.971030023-1969) (P. Ashby 2934-1969); 35 km N Minilya (P.33173, C.209696-1967); Williambury Stn, Kennedy Range (P. Cranfield 1915-1981); Manberry Stn 24°02'-114°09' (P. Gardner 3029-1932); Henry River, Barlee Range (P. Royce 6534-1961); Onslow (P. Pfeiffer-1977); 20 km E Onslow (C.297493-1979); Barrow Island (P. Butler 104-1973); 22 km NE Fortescue (A.97810436-1977); between Coolawanyah and Hamersly Stations, Hamersly Range (P. Blockley 339-1966); Mt Margaret, Hamersly Range (P. Gardner 3133-1932); Rudall River 22°35'-122°10' (P. Wilson 10305, A.98837039-1971); between Lake Disappointment and Robertson Range (P. Royce-1973); Port Hedland (P.George 1100-1960); DeGrey River (P. Burbidge 1145-1940); on *A. glabrata*: Geikie Gorge (A.96808313, P. Bennett 1959-1967); Ord River Gorge (P. Gardner 7330-1944). **Northern Territory** on *A. hookeri*: Mann Range, 35 km NE Mt Davies Camp (P.ex NT28867-1970); Mt Conner Hstd (A.97342248, A.97342249-1973); 65 km N Uluru (A.97407001-1935); George Gill Range, Bagot Springs Ck, 32 km E Kings Canyon (C.225618-1966); Curtin Springs Hstd (A.97615070-1974); 12 km NW Areyonga (A.97017062-1968); 40 km W Hermannsburg (A.96242275-1954); Palm Valley (A.96216027-1954); 48 km SSW Alice Springs on Stuart Hwy (B.376110, C.264050-1977); 43 km SSW Alice Springs (C.33042-1954); 39 km SSW Alice Springs (A.96002077, C.92911-1956); 35 km SSE Aileron (A.96942067-1969); NW Stock Route, 3 km NW Desert Bore approx. 23°06'-132°46' (A.98935008, B.231378-1950); 21 km NW Desert Bore, Hamilton Downs approx. 23°00'-132°40' (C.63477-1955); 11 km SW Inningarra Range 20°50'-129°37' (A.97049475-1970); 48 km SE Alice Springs (A.95952029-1956); Bundooma (A.98031072-?); NW Simpson Desert 24°34'-135°51' (C.331189-1982); NW Simpson Desert 24°03'-136°34' (A.97615252-1973); Simpson Desert 25°15' 50" 136°43'35" (A.96733058, A.96733059-1966); Simpson Desert 24°53'-136°30' (A.96832166-1959). **Queensland** on *A. hookeri*: 3 km S Carlo, East Simpson Desert approx. 23°28'-138°40' (B.232978-1977); 19 km SE Monkira 24°57'-140°31' (B.247284-1978). **South Australia** on *A. hookeri*: Cordillo Downs 26°42'-140°47' (A.96806449-1924) (A.97916052-1963); near junction Montkeleary and Dripie Cks 27°02'-140°41' (A.97539292, A.97539293-1975); 9 km N Leap Year Bore 26°59'-140°57' (A.98828229-1988); 9 km NE Leap Year Bore 27°04'-140°57' (A.98425595-



Figs 3-6. SEM photographs of Egg Type 1 (*T. albocincta* likely) collected from herbaria specimens of *Adriana*: (3) Ooldea, SA; (4) Musgrave Range, SA; (5) Minilya, WA; (6) Geikie Gorge, WA.

1976); Marqualpie Paddock, Innamincka Regional Reserve approx. 26°54'-140°49' (A.99136051-1991); Tieyon Stn 26°12'-133°51' (A.98024004-1973); Mt Harriet Rd, 35 km S Musgrave Park Station, Musgrave Range (A.96648124-1966); 18 km NE Deering Hills (A.97840262-1978); 15 km NE Mt Cooperinna (A.97843097-1978); Spinifex Camp, Deering Hills 26°19'-129°53' (A.97904018-1955); Tomkinson Range (A.96806448-1954); 18 km NE Mt Kintore 26°27'-130°37' (A.97844336-1978); 6 km ENE Mt Moulden (A.97845188-1978); 5 km SE Cheessman Junction



Figs 7-9. SEM photographs of lycaenid eggs collected from herbaria specimens of *Adriana*: (7) Egg Type 2 (*T. h. littoralis* likely), Fitzgerald R., WA; (8) Egg Type 3 (*T. albocincta* as lectotype likely), Banana, Qld; (9) Egg Type 4, Yatton Creek, Qld.

(A.97838080-1978); near Serpentine Lakes 28°31'-129°00' (A.98535048-1979); Ooldea Soak (A.96806447-1939) (C.70375-1956); Thurlga Gate, Gawler Range (A.96942367-1969); Scrubby Peak, Gawler Range (A.97934059-1967); on *A. klotzschii* (known adult butterfly localities not recorded): Elliston (A.96805518-1967); SE Meningie, N side of Coorong

(C.242135-1965).

Egg Type 2 (*T. h. littoralis* likely): **Western Australia** on *A. quadripartita*: Bremer Bay (P.Aplin 2772-1963); near mouth Fitzgerald River Inlet (P. Aplin 3649-1970); Esperance (P. Royce 6315-1960).

Egg Type 3 (*T. albocincta* lectotype likely): **Queensland** on *A. glabrata*: Bauhinia Downs (B.284623-1968); 20 km SE Rolleston on Duaringa Hwy (B.249307-1978); Banana (C.107447-1961); Warren State Farm (B.360204-?); Yatton Ck near Croydon, 93 km NW Marlborough (B.191925-1973); 50 km N Clermont (B.305959-1983); Bullock Ck, 65 km E of Hughenden (B.360207-?).

Egg Type 4: **Queensland** on *A. glabrata*: Between Spring Bluff and Murphys Ck (B.360192-1930); Canungra (B.360198-1917); North Pine River, Petrie (B.210650-1932); Caboolture (B.360196-1955); Banana (C.107447-1961); Marlborough (B.360209-1956); Yatton Ck near Croydon (B.191925-1973); Port Mackay (B.360208-1873).

Surprisingly, no eggs were recovered from *A. quadripartita* within its distribution from Geraldton to Bunbury. Photographed egg specimens are stored at the South Australian Museum.

Discussion

This study has shown a wide distribution for *T. albocincta* (Egg Types 1 and 3), being more compatible with foodplant distribution. No evidence for its distribution was found in New South Wales or the montane areas of eastern Victoria. The revised distribution (Fig. 2) includes north-west Western Australia, central Australia, South Australia, north-west Victoria and central Queensland. It includes Barrow Island in Western Australia and Kangaroo Island in South Australia. It is likely to occur also in western New South Wales and along the southern coast of Victoria, based on foodplant distribution and general habitat data.

The lack of adult records in Queensland and New South Wales is unusual considering the large number of lepidopterists in those states. The fact that *Adriana* is considered to be a poisonous weed by eastern state farmers and eradicated on sight may be one reason. Confusion in the field between *T. albocincta* and *Theclines thes serpentata* (Herrich-Schaffer) may be another.

The distribution of *T. h. littoralis* (Egg Type 2) has been extended west from Esperance to the Albany area. The small area of distribution of *A. quadripartita* in south-west Western Australia poses a conservation problem for *T. hesperia* in the future.

Interestingly, the *Adriana* distribution exhibits well defined concentrations in different parts of Australia and the available records of *T. albocincta* adult butterflies suggest there may also be endemic varietal populations of *T. albocincta* associated with these different *Adriana* concentrations. In the

north-west of Western Australia the *T. albocincta* Form 4 (Sibatani and Grund 1978) is associated with a concentration of *A. tomentosa*. In southern South Australia the *T. albocincta* Form 3 is associated with *A. klotzschii*. In central Australia the *T. albocincta* Form 2 is associated with *A. hookeri*. The north-west Victoria population of *T. albocincta* on *A. hookeri* may also belong to this group. In central Queensland the *T. albocincta* Form 1 is associated with *A. glabrata*. The eggs of Forms 2, 3 and 4 are indistinguishable from each other. Egg Type 3, probably associated with the lectotype of *T. albocincta*, is quite distinct and may ultimately indicate that populations with Egg Type 1 belong to a different species.

The strongly different Egg Type 4, which is not associated with any *T. albocincta* adult butterfly records, has prompted lepidopterists to suggest that other lycaenid species are also involved in egg laying on *Adriana*, particularly the closely related *T. serpentata* and *Theclinessthes miskini miskini* (T.P. Lucas). The foodplants for the latter two species, respectively Chenopodiaceae and Leguminosae/Mimosoideae in South Australia, and for *T. albocincta* often grow side by side in the field and, in the author's experience after rearing a large number of *T. albocincta*, these butterflies do not use each other's foodplants. With this in mind further experimentation and a close look at the life histories of the other *Theclinessthes* species was undertaken.

The egg of *T. s. serpentata* in South Australia (Fisher 1978, p.223) is similar to that of *T. albocincta* (Egg Type 1, also Fisher 1978, p.220) but differs in that the intra-reticulation area is smaller and often irregular and the processes are markedly reduced. Larvae of *T. serpentata* would not eat any part of *A. klotzschii* at any stage of instar development.

The egg of *T. m. miskini* (Fisher 1978, p.218) is similar to that of *T. serpentata*, except the reticulated pattern is more regular and the processes are better developed but still not as developed as in *T. albocincta*. First instar larvae would accept the yellow male stamens of *A. klotzschii* and attained about the third or early fourth instar before death.

Whilst revising this paper the author encountered a second instar larva of *Nacaduba biocellata biocellata* (C. & R. Felder) on a male flower spike of *A. klotzschii*, collected during a vegetation survey in southern Eyre Peninsula, but unfortunately could not verify if the larva had translocated from the blossom of *Acacia anceps* DC. during the course of the field collection. This larva continued to eat the yellow stamens of the male *Adriana* flowers and finally pupated, but unfortunately was parasitized. Immature *N. biocellata* larvae were then experimentally introduced to male *Adriana* flowers and one larva was eventually reared which pupated normally and emerged as a perfect female. The author has examined hundreds of *A. klotzschii* both before and after these experiments and has never encountered *N. biocellata* either in the egg or larval stage, although adult butterflies occasionally use the *Adriana* flowers and nectary glands for feeding and it is therefore possible an

occasional female may lay eggs on the open male blossom, especially if there is ant activity. The egg of *N. biocellata* is slightly smaller than that of *T. albocincta* and, although the reticulated pattern is coarse like *T. albocincta*, the pattern differs by being distinctly hexagonal. The reticulation intersections are not raised.

Further collecting of adults and immature stages is required to confirm that the distributions of *T. albocincta* and *T. hesperia* are more extensive, particularly in tropical and eastern coastal areas for *T. albocincta* and in south-west Western Australia. Further examination of the taxonomic relationship between *T. albocincta*, *T. h. hesperia* and *T. h. littoralis* is also required. Live material of all the forms and variants of both species is required by the South Australian Museum so that allozyme studies can be undertaken.

Acknowledgments

To Jan Forrest of the South Australian Museum for help with the SEM photography and to the SAM for permission to use the SEM and for access to distribution software. To the Perth, Adelaide, Canberra and Brisbane Herbaria for permission to examine specimens of *Adriana* and to remove eggs for SEM photography. To the Alice Springs, Darwin, Melbourne and Sydney Herbaria for forwarding *Adriana* distribution data. This project was carried out with the partial assistance of funds made available by the Commonwealth of Australia under the National Estate Grants Program.

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AN UNUSUAL TEMPORALLY ISOLATED POPULATION OF *NEOLUCIA AGRICOLA* WATERHOUSE & TURNER IN WESTERN AUSTRALIA (LEPIDOPTERA: LYCAENIDAE)

A. J. GRAHAM¹, H. H. BOLLAM² and M. WILLIAMS³

¹ W. A. School of Mines, Curtin University of Technology, PO Box 597, Kalgoorlie, WA 6430

² Glen View, Lot 10, Julimar Rd, Chittering, WA 6084

³ Department of Conservation and Land Management, Perth, WA

Abstract

A temporally isolated population of *Neolucia agricola occidens* Waterhouse & Lyell referred to as *N. a. occidens* 'Julimar' is recorded from Western Australia. The 'Julimar' population is distinguished from others by the smaller size, generally darker colour and flight period, March-April. The only known host is the immature flower buds of *Daviesia angulata* (Fabaceae).

Introduction

Neolucia agricola Waterhouse & Turner is a small brown lycaenid which occurs from central Queensland to South Australia, south-west Western Australia and Tasmania, with subspecies *N. a. occidens* Waterhouse & Lyell occurring in the western part of its range. The adults have been recorded previously from September to February, with some southern coastal and higher altitude populations flying in January-February. For other populations the predominant flight period is September to November (Common and Waterhouse 1981).

Neolucia agricola occidens form 'Julimar' (Figs 1-4)

Material examined. Western Australia: 78 ♂♂, 20 ♀♀, Julimar Conservation Park, near Perth, 18 & 19.iv.1993, 14.iv.1994, 29 & 30.iii.1995, 4.iv.1995, A.J. Graham, H.H. Bollam, M.R. Williams, R.W. Hay and P. Hutchinson.

Description. Male (Figs 1, 2) consistently smaller than typical *N. a. occidens*; size 18-20 mm. Above dark brown with a bronze iridescence, terminal fringes distinctly chequered dark brown and white. Beneath light to mid-brown, apex and terminal areas grey-brown; forewing with a fine dark brown terminal line, subterminal dark brown marks between veins M_2 and M_3 , M_3 and CuA_1 , CuA_1 and CuA_2 sometimes obscure, an irregular series of five brown postmedian marks between veins R_5 and M_1 , M_1 and M_2 , M_2 and M_3 , M_3 and CuA_1 , CuA_1 and CuA_2 , edged white, plus two brown bars edged white in cell; hindwing with a fine dark brown terminal line, irregular brown and white patches in basal and median areas and two distinct brown-black, inverted V-shaped markings, edged above cupreous, between veins M_3 and CuA_2 ; occasional similar but obscure subterminal dark brown, inverted V-shaped markings above vein M_3 . Similar to *N. a. occidens* (Figs 5-8) but darker, with slightly increased greyness, especially on underside.

Female (Figs 3, 4) similar to male but slightly larger; size 19-21 mm. Wings rounder and paler above; markings on underside more distinct.

Etymology. This population is named after Julimar, the name applied to WA State Forest No. 61, where it was discovered by A. J. Graham and H. H. Bollam on 18 April 1993. The meaning of the name Julimar is not evident but was first used by G.N. Rowe in 1867, while surveying 'Jullimurring Brook' (WA Department of Land Administration, *pers. comm.*).

Distribution and Flight Period

Recorded only from the Julimar Conservation Park, approximately 85 km north of Perth, Western Australia, where it flies in March and April. This locality is approximately 60 km from the nearest known populations of *N. a. occidens* at Warwick and Burns Beach. Other Western Australian populations fly from October to January.

Life History

Food plant: *Daviesia angulata* Benth. (Fabaceae).

Egg: Not yet observed.

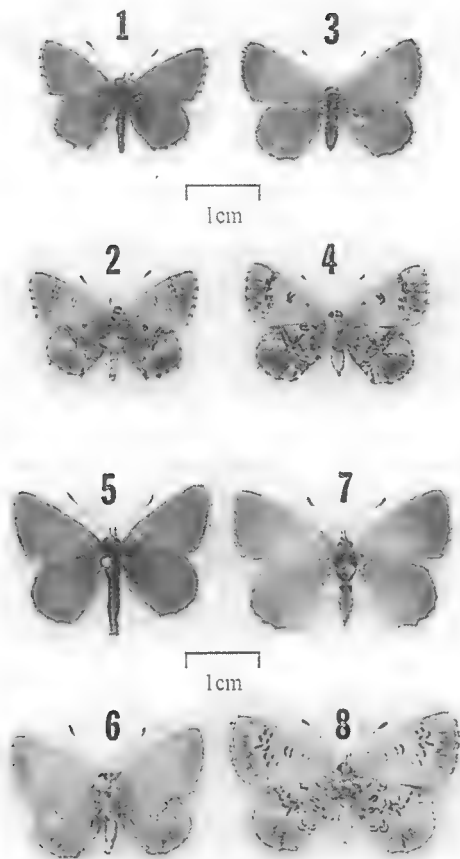
Final instar larva: Differs from Fisher's (1978) description of the larva of *N. a. agricola* which, however, are known to be variable in colour (Fisher 1995). Smooth; basic colour mid-green; broad dark green dorsal stripe and lateral stripes; thin yellow line between green dorsal and lateral stripes; slightly thinner pale yellow lateral stripe on each side just above legs; two brilliant red eye-like spots just behind the head. Size up to 8 mm x 3 mm x 2 mm. No ants were observed in attendance.

Pupa: Dark speckled grey-brown with scattered darker brown markings; thin dark brown dorsal line over thorax and abdomen; head with crescent shaped dark brown line over each eye. Length approximately 6 mm. Pupation takes place in leaf litter and not on foodplant; it lasts approximately 10 days. First known emergence 29 March.

Discussion

Larvae feed on the immature flower buds of the hostplant. Normally only a single immature bud from each inflorescence is eaten before the larva moves onto a new inflorescence. This habit makes it very difficult to locate larvae as large scale damage to the plant is avoided. Larger buds and flowers are not eaten. Of the 18 species of *Daviesia* Smith recorded from the Perth Region and south-west Western Australia (Marchant *et al.* 1987), only *D. angulata* (and occasionally *D. preissei* Meissner) flowers in the Autumn. The flowering period for *D. angulata* at Julimar is mid-March to end of April.

Species of other reported larval foodplants (Common and Waterhouse 1981), in genera *Aotus* Smith, *Bossiaea* Vent., *Dillwynia* Smith, *Eutaxia* R. Br. and *Pultanea* Smith, do occur in the Perth Region and south-west Western



Figs 1-8. *Neolucia agricola occidens*. (1-4) Form 'Julimar' (April): (1, 2) male upper and undersides; (3, 4) female upper and undersides. (5-8) Normal form (October): (5, 6) male upper and undersides, Leeming, WA; (7, 8) female upper and undersides, Jandakot, WA.

Australia but flowering periods are generally from May to February (Marchant *et al.* 1987). Thus *Daviesia. angulata* is likely to be the only foodplant capable of supporting an autumn brood for *N. agricola*.

Further collecting in and around Julimar is being undertaken in order to more clearly establish the distribution and status of this population and determine how its distribution relates to other populations of *N. a. occidens*.

Acknowledgments

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A CHROMOSOME STUDY OF AUSTRALIAN ORNITHOPTERA BOISDUVAL (LEPIDOPTERA: PAPILIONIDAE)

J. HASENPUSCH¹ and P. POPESCU²

¹ Australian Insect Farm, PO Box 26, Innisfail, Qld 4860

² 10, Place Corneille, 92100, Boulogne, France

Abstract

Chromosome numbers of $n=30$ are observed in *Ornithoptera euphorion* (Gray), *O. richmondia* (Gray) and *O. priamus poseidon* form-loc. *macalpinei* Moulds.

Introduction

The Lepidoptera show a great range in chromosome number, from $n=7$ to $n=220$, with a modal chromosome number at 29-31 (White 1973). Several Lepidoptera families have a different subsidiary mode, such as $n=23-24$ for Lycaenidae and $n=31$ for Nymphalidae. This study reports, for the first time, the chromosome number of the Australian birdwing butterflies of the *priamus* species-group, *Ornithoptera euphorion* (Gray), *O. richmondia* (Gray) and *O. priamus poseidon* form-loc. *macalpinei* Moulds. Specific nomenclature follows Nielsen *et al.* (1996).

Material and Methods

Karyological observations were carried out on both male and female, newly emerged adults bred in Innisfail. After 0.05% colchicine treatment for 2 hrs, the testes and ovarioles were dissected out and disassociated in a 1% sodium citrate solution for 20 minutes. After fixation in freshly made acetic acid-methanol (1:3) for at least 1 hr, the cell suspension was allowed to spread over a slide and air dried. Dispersion and evaporation of the fixative was facilitated by gently blowing over the slide. The slides were stained in 4% Giemsa in Sorensen phosphate buffer (ph=6.8) for approximately 30 minutes. The chromosomes were examined and photographed at magnification approximately 2700x.

Results and Discussion

During the male meiosis metaphase I stages, 30 bivalents are observed in all three species examined. In spermatogonial metaphases 60 chromosomes are clearly visible in all three species. The chromosomes are rod or dot shaped. This aspect may be interpreted by assuming the holocentric nature of chromosomes of Australian *Ornithoptera*, as has been described previously in other Lepidoptera groups (Maeki 1980).

According to Haugum and Low (1978-79), form-loc. *macalpinei* is a southern form of *O. p. pronomus* (Gray), which occurs at Cape York. Thus it is probable that all Australian populations of *Ornithoptera* have a modal number group of $n=30$ chromosomes.

To understand the karyotype evolution of *Ornithoptera* butterflies, it would

be interesting to analyse other species from the islands of New Guinea and the Solomons. As reported by Straatman (1976), hybridisation between sympatric birdwing taxa may occur in the field. Karyotype analysis may prove a useful tool in verifying a hybrid condition.

Acknowledgments

We are grateful to the Queensland Department of Environment and Heritage and the Australian Nature Conservation Agency, without whose assistance this study would not have been possible.

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THE LIFE HISTORY OF *ARHOPALA WILDEI WILDEI* MISKIN (LEPIDOPTERA: LYCAENIDAE)

A.J. KING¹ and L.R. RING²

¹GPO Box 1302, Townsville, Qld 4810

²C/- Malacca Butterfly and Reptile Sanctuary, Ayer Keroh, 75450 Melaka, Malaysia

Abstract

The life history of *Arhopala wildei wildei* Miskin is described and notes presented on its biology and behaviour. *A. w. wildei* larvae were observed to be myrmecophagous and confined within nests of the arboreal ant *Polyrhachis queenslandica* Emery (Hymenoptera: Formicidae: Formicinae).

Introduction

Four species of *Arhopala* Boisduval occur in Australia, distributed from northern Western Australia to Cape York and then south to Tannum Sands in south eastern Queensland (Hacopian 1992). *A. w. wildei* Miskin has been recorded from Cape York south to Conn Creek, south of Cardwell (Braby and Dunn 1991) and has been collected at Kuranda in highland vine forest near the Barron River (J. Olive coll.). *A. w. wildei* adults have been observed on occasions to be locally common. With the exception of *A. w. wildei* all Australian representatives of the genus are phytophagous with both larvae and pupae being attended by the green tree ant *Oecophylla smaragdina* Fabricius (Formicidae) but apparently not dependant on the ants for survival.

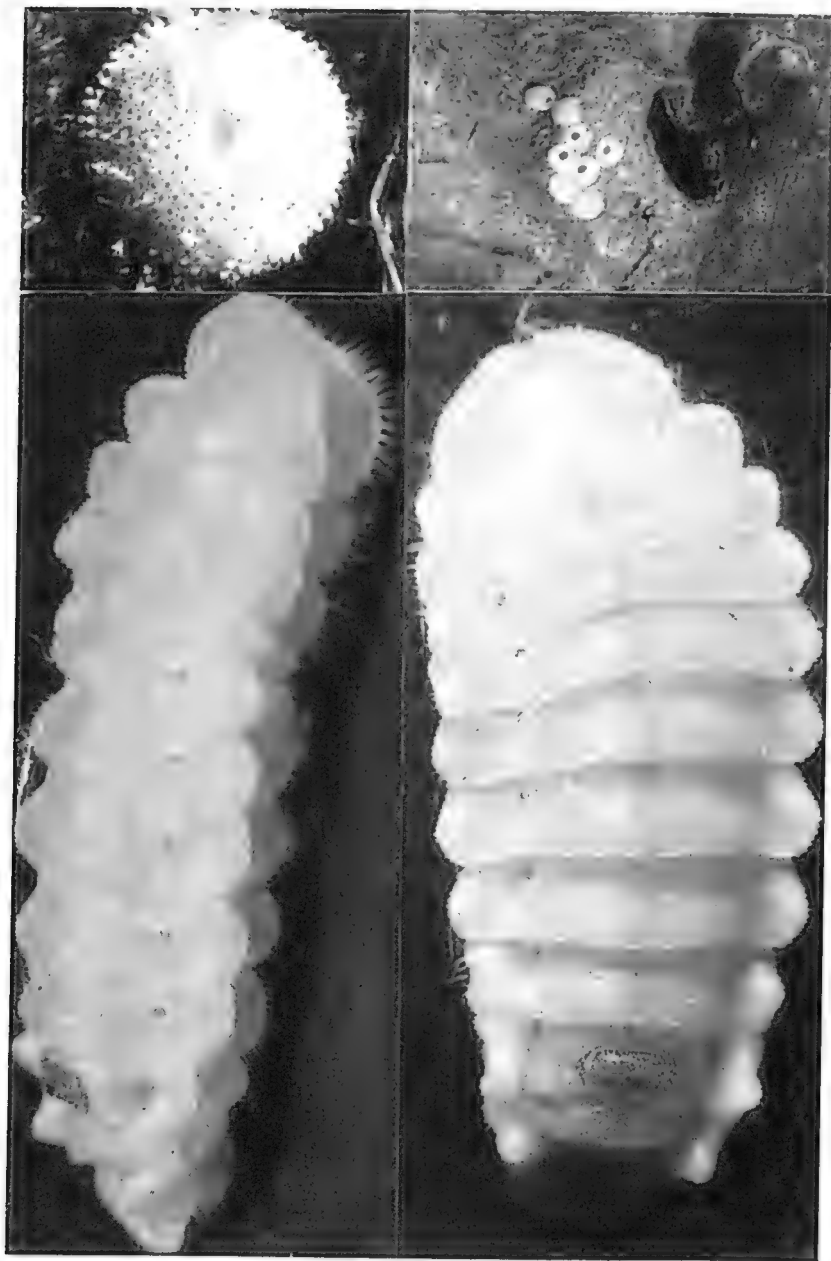
The genus *Polyrhachis* F. Smith contains at least 114 Australian species, both arboreal and terrestrial, with the known distribution of *P. queenslandica* Emery extending from just north of Townsville to Cape York and in the Northern Territory around Darwin (R. Kohout pers. comm.). *P. queenslandica* ants build arboreal nests by joining together the edges of overlapping leaves with dried plant fragments and silk.

Life History

Egg (Figs 1, 2) 1.0 mm wide and 0.3 mm high, bluish white fading to white, circular, very flattened, slightly domed on both sides with a prominent micropylar depression at top centre. The upper middle surface is covered in small, evenly spaced and slightly raised domes, each with an irregularly rounded central depression, which transform into a narrow band of short, uneven and somewhat pointed projections around the circumference. The egg has no ridges either radiating or oblique.

First Instar Larva. 2.0 mm long, translucent white with the head pale brown and a dark patch visible under the prothoracic plate. Numerous fine, long translucent setae are present on the upper head and forward edge of the prothoracic plate. Sparse, short, pointed and appressed translucent setae are present on the dorsal surface.

Third Instar Larva. 5.0 mm long, translucent white and flattened with a pink suffusion developing on the mid-dorsal surface. An obscure median dorsal



Figs 1-4. *Arhopala wildei wildei*. (1) egg; (2) eggs on nest wall; (3, 4) lateral and dorsal views of mature larva.



Fig. 5. *Arhopala wildei wildei*, pupa in nest.

organ is visible on the seventh abdominal segment. The head is yellow-brown and the spiracles are black.

Mature Larva (Figs 3, 4) 18.0 to 20.0 mm long and 5.0 mm wide; dorsal surface flattened, prothoracic plate rounded, convex and hoodlike with the forward edge raised and thickened. From the prothoracic plate to abdominal segment eight, segment divisions conspicuous with the dorsolateral margin extended and becoming raised towards the posterior. A large, ovoid, median dorsal organ edged in brown and with a prominent transverse slit is present on the seventh abdominal segment; segments eight and nine narrowing and sloping into a deeply concave anal plate on segment ten. A conspicuous lateral fringe of long translucent setae runs the entire length of the body. Mature larvae are white to cream with the head pale yellow, the spiracles edged orange-brown and the mid-dorsal vessel visible as a thin brown pulsating line. The larvae were not observed to have tentacular organs present.

Pupa (Fig. 5) 16.0 to 18.0 mm long and 6.0 mm wide, slightly humped and widest at the mid-section with the abdominal segments narrowing to an elongated anal disc. Pupae are dull light brown with a darker brown thorax and the spiracles are obscure. They are attached to a pad of silk by anal hooks and a silken girdle inside the ants' nest.

Observations

A. w. wildei females were observed to lay one to three eggs at a time on *P. queenslandica* nests with the eggs usually laid on the nest wall or occasionally on leaves proximal to the nest entrance. *A. w. wildei* eggs

visible on *P. queenslandica* nests graduated from pale blue to white and intact, through white to grey empty shells, to black fragments embedded in the nest wall. Small *P. queenslandica* nests ($ca < 10\text{cm}^3$) attracted only one to three eggs while larger nests had many eggs laid in succession by a number of *A. w. wildei* females. One larger *P. queenslandica* nest ($ca 90\text{cm}^3$) had, attached to its side, 12 intact *A. w. wildei* eggs, 26 empty shells of various ages and an uncertain number of blackish egg fragments embedded in the nest wall. A small number of *A. w. wildei* eggs were occasionally found to be present on the arboreal nests of a physically similar species, *Polyrhachis yarrabahensis* Forel, but no later stages were found.

On emerging from the egg *A. w. wildei* larvae are carried by *P. queenslandica* ants into the nest and deposited near the ant brood where they are attended by numerous ants. Up to 15 *A. w. wildei* larvae of various instars were observed in large *P. queenslandica* nests and it was also noted that the larvae were often lined up side by side on the bottom of the nest. *A. w. wildei* larvae were observed to consume the contents of *P. queenslandica* eggs after which the cuticle was discarded. *P. queenslandica* ants were observed to attend the median dorsal organ of resident *A. w. wildei* larvae for exudates which at times was observed to accumulate in the concave anal depression. A number of *A. w. wildei* pupae observed in *P. queenslandica* nests in the wild were attached to a pad of silk on the nest wall by anal hooks and a silken girdle. On emergence *A. w. wildei* adults would have to pass the ants and exit the nest through the narrow access holes. No *A. w. wildei* adults were observed emerging from *P. queenslandica* nests in the wild.

Acknowledgments

We are indebted to Rudy Kohout of the Queensland Museum for identification of the ants, Mike Cermak of Townsville for photographs of the early stages, Peter Samson of Bundaberg for the photograph of the egg and to Rod Eastwood of Brisbane for helpful comments on the manuscript. Thanks also to Lance Veivers of Waugh's Pocket for allowing continued access to his property, making possible the discovery and observation of this remarkable life history.

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NOTES ON EXTRA-PHYTOPHAGOUS FOOD SOURCES OF
GELONUS TASMANICUS (LE GUILLOU)
(HEMIPTERA: COREIDAE)
AND *DINDYMUS VERSICOLOR* (HERRICH-SCHÄFFER)
(HEMIPTERA: PYRRHOCORIDAE)

MARTIN J. STEINBAUER¹

Co-operative Research Centre for Temperate Hardwood Forestry, GPO Box 252-12, Hobart, Tas., 7001

Abstract

Two species of phytophagous Heteroptera, *Gelonus tasmanicus* and *Dindymus versicolor*, were observed feeding upon extra-phytophagous food sources in Tasmania. The substances fed upon included bird and mammal faeces and dead arthropods and lizards. Adults and nymphs of *D. versicolor* were observed feeding upon these substances, however, only nymphs of *G. tasmanicus* were recorded feeding upon extra-phytophagous food sources. This is the first record of a pyrrhocorid feeding upon such substances.

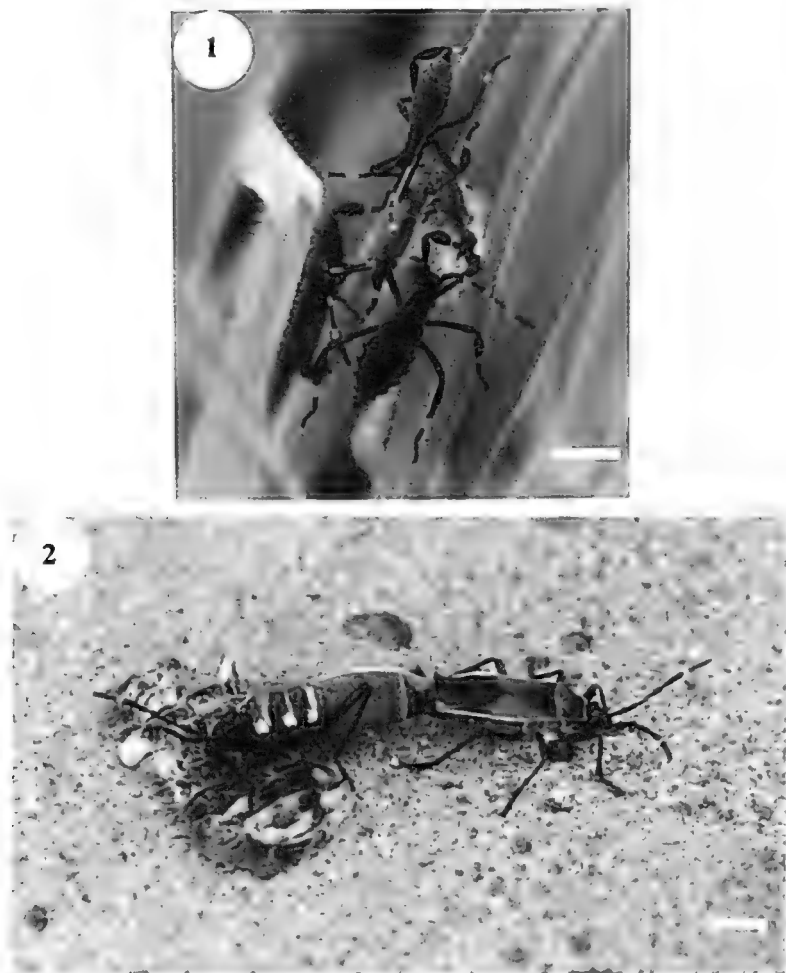
Introduction

Adler and Wheeler (1984) list 33 species of plant feeding Heteroptera as having been recorded feeding upon extra-phytophagous substances, of which 70% belonged to the families Alydidae and Coreidae. Interestingly, species of pyrrhocorid bug were not cited in this list. The extra-phytophagous substances recorded include bird droppings, dung and carrion. Although carrion has often been associated with the Alydidae, the use of dung by true bugs has rarely been reported (Adler and Wheeler 1984). In addition, these authors reported that only adults had been observed feeding upon such substances, however, Ralph (1976) observed cannibalistic behaviour in *Oncopeltus fasciatus* (Dallas) (Hemiptera: Lygaeidae) nymphs. Dolling (1991) considered that bugs feeding on extra-phytophagous substances may obtain essential nutrients lacking in their normal diet of plant sap. Some evidence to support this suggestion is given by Ralph (1976) who reported that nymphs of *O. fasciatus* fed upon dead and weak nymphs of the same species when reared on nutritionally inferior substrates.

Observations

On the 28.i.1993 large numbers of *Gelonus tasmanicus* nymphs were observed amongst the leaf litter and vegetation beneath *Eucalyptus nitens* (Deane & Maiden) Maiden at a plantation near West Ridgley (41°09'S 145°49'E), northern Tasmania. A collection of 173 individuals comprised 3 I, 98 II, 40 III, 22 IV and 9 V instars and one adult ♀. On this occasion, a number of nymphs ranging from second to fifth instars were observed probing bird droppings found on surrounding grasses and weeds (Fig. 1). The adult female was not observed feeding upon these substrates. These droppings were not recent and thus quite dry. Such behaviour was not

¹ Present address: CSIRO Division of Entomology, Tropical Ecosystems Research Centre, PMB 44, Winnellie, NT, 0281



Figs 1 and 2. (1) Nymphs of *G. tasmanicus* feeding on a bird dropping at West Ridgley, Tas. (scale line = approx. 3.5 mm); (2) A female *D. versicolor* feeding on part of a lizard tail while *in copula*, Dynnyrne, Tas. (scale line = approx. 5.0 mm).

observed in *Amorbus obscuricornis* (Westwood) (Hemiptera: Coreidae) which is also endemic to Tasmania (pers. obs).

Numerous observations of similar behaviour by *Dindymus versicolor* have been made at Dynnyrne (42°54'S 147°16'E), southern Tasmania. Adults and nymphs of this species have been regularly observed feeding upon the bodies of dead *Dindymus* and other arthropods (e.g. millipedes), dead lizards (Fig. 2)

and the droppings of birds and mammals. Typically, large aggregations of bugs can be attracted to such substances particularly when they are fresh and high in moisture. However, bugs will keep returning even when the resource is quite dry. The droppings fed upon by these bugs were not observed to contain seeds or other larval inhabitants upon which the bugs may have been feeding as reported by Adler and Wheeler (1984).

Discussion

Coreids typically feed on the vascular systems of plants while pyrrhocorids are seed and fruit feeders (Schuh and Slater 1995). Whether these phytophagous bugs benefit from "supplementing" their diets with nutrients from such sources remains to be investigated. For example, are these insects increasing the nitrogen content of their diet of plant exudate, which is typically low in this important element, by feeding on such substances? Should bugs be found to enhance the nitrogen content of their diets through ingesting such substances it would be interesting to ascertain whether this behaviour enhances the fecundity of females. For example, Hendrichs *et al.* (1993) found that female *Ceratitis capitata* (Wiedemann) (Diptera: Tephritidae) fed a diet of figs and bird faeces were significantly more fecund than those insects only given figs. Perhaps coincidentally, it is interesting to note that during three years studying *G. tasmanicus* this was one of the largest congregations of this species found and was the only occasion on which first instar nymphs were collected from the field (Steinbauer 1995). Similarly, large numbers of *D. versicolor* survive year round at Dynnyrne (pers. obs).

Also of interest is the mechanism by which these insects metabolise nutrients from these sources. Proteinases are known to occur in phytophagous Heteroptera belonging to the families Lygaeidae, Pentatomidae and Miridae (Miles 1972) and it is possible they are also present in the two species considered here.

Acknowledgments

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A NEW SPECIES OF AUSTRALIAN *PACHYHALICTUS* COCKERELL (HYMENOPTERA: HALICTIDAE)

Kenneth Walker

*Museum of Victoria, Department of Entomology, 71 Victoria Crescent, Abbotsford, Melbourne,
Victoria 3067*

Abstract

Pachyhalictus albipilatus sp. nov. is described from north Queensland and compared with *P. stirlingi* (Cockerell). New distributional records for the latter species are presented.

Introduction

Pachyhalictus Cockerell, known from 31 species found mainly in the Asiatic tropics, has one described species in Australia, *P. stirlingi* (Cockerell) (Walker 1993). The genus is characterised, in both sexes, by coarsely reticulate sculpture markings on the frons, vertex, mesoscutum and scutellum (See Michener 1978 for full generic character listing and Walker 1993 for character comparison with *Homalictus* Cockerell). *Pachyhalictus* is unique within the Australian Halictini in possessing strong venation in the forewing submarginal cells of the female. In addition, the fused first and second hind tarsal segments of the male is a highly unusual character. Examination of *Pachyhalictus* specimens collected on and in conjunction with the 1992 "Heathlands" expedition to Cape York Peninsula, revealed seven specimens of an undescribed species. This second species, *P. albipilatus* sp. nov., is described and compared with *P. stirlingi*.

Terminology and abbreviations

The terminology of morphological features follows Walker (1993). Abbreviations: ANIC Australian National Insect Collection; AOD Antennocular distance; CL Clypeal length; EW Eye width, in side view; FL Flagellum length; GW Genal width, in side view; HL Head length; HW Head width; IAD Interantennal distance; IOD Interocellar distance; LID Lower interorbital distance; OAD Ocellantennal distance; OOD Ocellocular distance; S2-S8 metasomal sterna 2-8; SL Scape length; T1-T6 metasomal terga 1-6; UID Upper interorbital distance.

Pachyhalictus Cockerell

'*Halictus nomiiformes*' Vachal, 1894: 428; Blüthgen, 1926: 400; 1931: 286.

Pachyhalictus Cockerell, 1929: 589 (Type species *Halictus merescens* Cockerell by original designation); Michener, 1978: 515 [full generic description].

Pachyhalictus albipilatus sp. nov.

(Figs 1-3, 7, 9-14)

Types. QUEENSLAND: *holotype* ♀, Schramm Ck (12°22'S 142°37'E), 17-21.viii.1992, J. Cardale & P. Zborowski (ANIC); *paratypes* (2♂♂, 4♀♀): 1♀, Cockatoo Ck. Xing, 17km NW of Heathlands (11°39'S 142°27'E), 7.vi-25.vii.1992, P. Zborowski & E. Nielsen, Malaise #5 open forest; 2♂♂ same data as holotype; 2♂♂, Moreton HS (12°27'S 142°38'E), 22.viii.1992,

J. Cardale & P. Zborowski; 1♀, 5km SSE of Helenvale (15°44'S 145°15'E), 25.viii.1992, J. Cardale & P. Zborowski, on *Xanthorrhoea* flowers. (All ANIC).

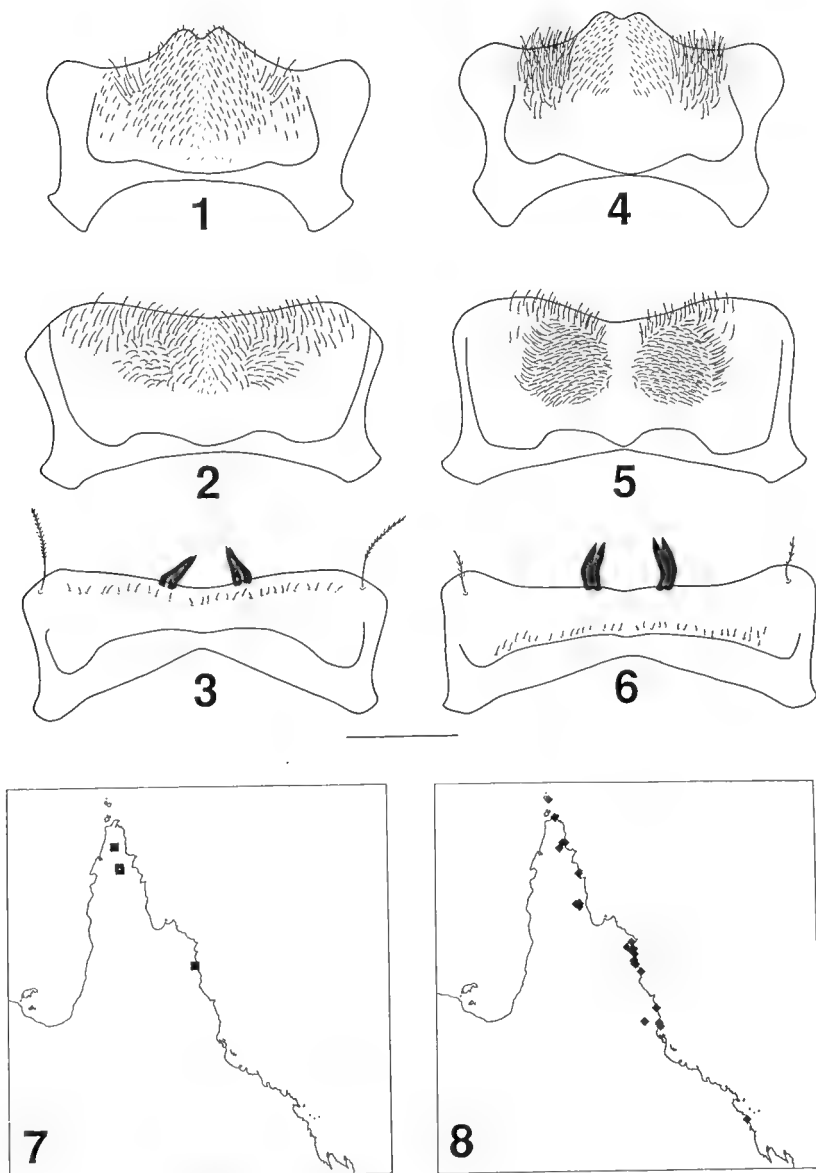
Diagnosis. Both sexes small, robust and black with frons, vertex, mesoscutum and scutellum coarsely reticulate; white tomentum on posterolateral areas of mesoscutum, metanotum, T2-T3 laterally (male), across T2-T4 (female); female with three teeth on inner hind tibial spur; male with S4 median bristles 1.2 x width of median ocellus, S5 setal pads with sparse vestiture.

Description. Female. Body length: 6.78-7.01 mm (\bar{x} =6.88 mm SD=0.12 n=3), (measurements of holotype in bold - **6.85** mm). Forewing length: 1.69-1.74 mm (\bar{x} =1.72 mm SD=0.03 n=3), (**1.69** mm). Head width: 2.26-2.30 mm (\bar{x} =2.28 mm SD=0.02 n=3), (**2.28** mm). Relative measurements: HW: 100; HL: **80-82**; UID: **55-56**; LID: **49-50**; AOD: **18-19**; IAD: **10-11**; OAD: **32-33**; IOD: **15-16**; OOD: **14-15**; CL: **18-19**; GW: **14-15**; EW: **25-27**; SL: **36-37**; FL: **64-66**.

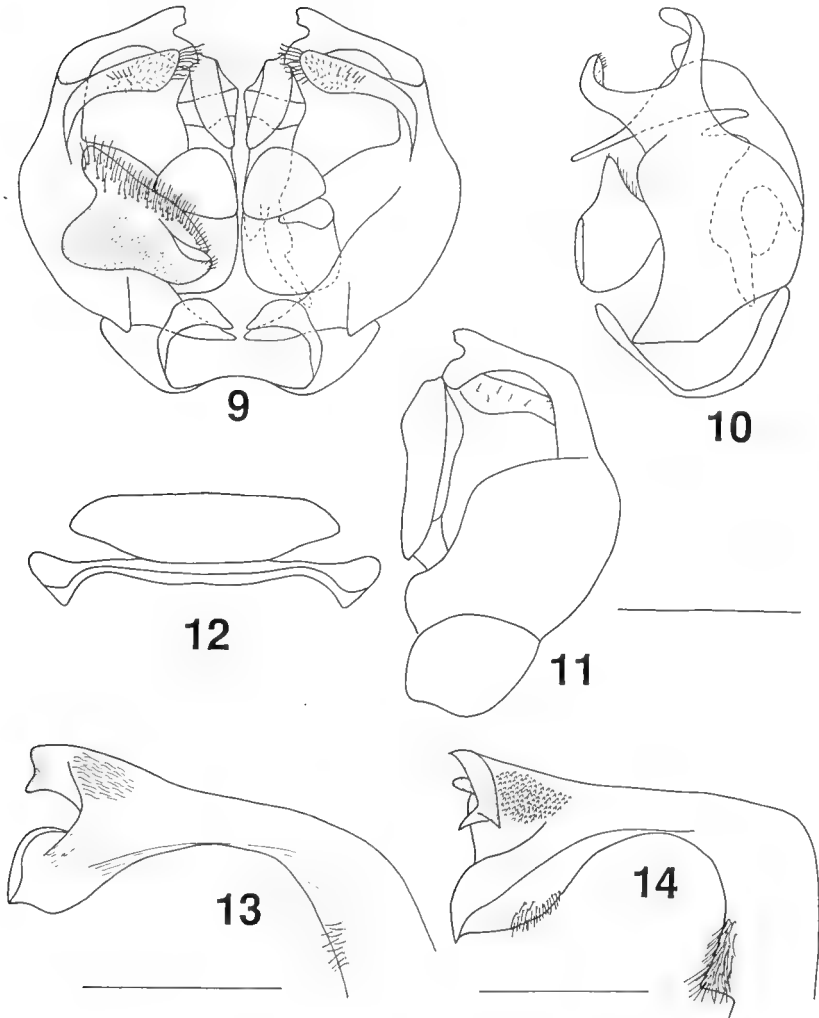
Structure. Frons, vertex, mesoscutum and scutellum coarsely reticulate; head broad, 0.80 x as broad as long; inner orbits converging below; median frontal carina extends 0.8 x to median ocellus; eyes with sparse cover of minute setae; scape reaches anterior margin of median ocellus; clypeus weakly concave along midline, strongly convex in side view, less than half extends below lower level of eyes, coarsely sculptured, punctate mesially, remainder with medially directed longitudinal striae; supraclypeal area protuberant and rounded, covered with reticulate pattern and weakly punctured. Labrum distal process triangular, smooth sided, tapering to pointed apex, median keel weakly flanged distally, fimbrial setae acutely pointed. Pronotum dorsolateral angles well projected and weakly obtuse; anterior half of mesepisternum reticulate, remaining mesepisternum and metepisternum striate; dorsal surface of propodeum length 0.75 x length of scutellum, sculpture coarsely areolate, posteromesial margin truncate, posterior and lateral margins defined by large carinae; hind basitibial plate well defined, apically acute; inner hind tibial spur pectinate with 3 large, rounded, apically directed teeth; T1 shining, mesial area and apical margin impunctate, remainder closely to densely punctate; remaining terga densely punctate.

Colour. Body black, mandibles dark red at apex, antennal flagellar segments and legs brown; some specimens with apical half of hind tibiae light red-brown; metanotum and metasoma tomentum white.

Vestiture. Frons with sparse, short, erect, branched hairs, paraocular areas with dense cover of adpressed plumose hair, genae with cover of both erect and adpressed branched hair except apically with some long, erect, simple hairs; mesoscutum with sparse cover of short, brown, erect, branched hair, except posterolateral tufts of tomentum; metanotum densely tomentose;



Figs 1-6. *Pachyhalictus* male metasomal sterna, (1-3) *P. albipilatus*., (4-6) *P. stirlingi*: (1, 4) S6; (2, 5) S5; (3, 6) S4. Scale line = 0.5mm. **Figs 7-8.** Known distributions of: (7) *P. albipilatus*; (8) *P. stirlingi*.



Figs 9-14. *Pachyhalictus* male genitalia: (9-12) *P. albipilatus*: (9) ventral view (note: left penis valve and volsella only partly drawn, right retrorse lobe omitted); (10) lateral view of male genitalia; (11) half dorsal view; and associated sterna: (12) S7 & S8. (13-14) Enlargement of ventral surface of the right gonostylus dorsal lobe, (13) *P. albipilatus*; (14) *P. stirlingi*. Upper scale line for Figs 9-12 = 0.5mm; scale lines beneath Figs 13-14 both = 0.2mm.

dorsal surface of propodeum posterolateral areas with moderate cover of erect, branched hairs; T2-T4 with tomentum extending across tergum.

Male. Body length: 5.78-6.24 mm (\bar{x} =5.95 mm SD=0.20 n=4). Forewing length: 1.41-1.50 mm (\bar{x} =1.46 mm SD=0.04 n=4). Head width: 1.81-1.93 mm (\bar{x} =1.86 mm SD=0.05 n=4). Relative measurements: HW: 100; HL: 82-85; UID: 58-62; LID: 46-47; AOD: 17-18; IAD: 12-13; OAD: 31-32; IOD: 16-17; OOD: 15-16; CL: 20-21; GW: 14-15; EW: 26-27; SL: 29-30; FL: 75-78.

Structure. Differs from female as follows: dorsal surface of propodeum areolate sculpture more compact and coarser; mandibles simple; eyes converging strongly below; scape extends to just short of anterior margin of median ocellus; labrum less developed, distal process weakly projected, with small median projection, median keel absent; pronotum dorsolateral angles bluntly acute; dorsal surface of propodeum 0.85 x length of scutellum; hind basitibial plate absent; inner hind tibial spur serrate with at least ten small, apically directed teeth; T1 openly to sparsely punctate except impunctate mesially and along apical margin; tomentum present on lateral areas of T2-T3; T6 (pygidial plate) posterior margin with raised carina; S6 with sparsely setose lateral hair tufts, median area with sparse vestiture (Fig. 1); S5 weakly concave along midline, median area with sparse vestiture, either side of midline with sparse cover of erect, simple hair forming two broadly rounded setal pads, median area with sparse vestiture (Fig. 2); S4 underneath and hidden by S3, S4 with two erect, acutely pointed bristles of similar length (approx. 0.18 mm) on either side of midline, lateral margins each with single, small, weakly branched bristle/hair approximately twice length of admedian bristle length (Fig. 3); S2-S3 with plumose hairs arising across apical margin; remaining vestiture similar to female except long, branched hairs on genae, metanotum tomentum reduced so that lateral areas hairless, T2-T3 with lateral tomentum only; fore, mid and hind trochanters and fore femora with long, branched hairs from ventral surface, hind leg and sternal scopae absent; first and second hind tarsal segments fused.

Colour. Body black except mandibles dark red apically, antennal flagellar segments brown underneath, tarsal segments light brown, T6 (pygidial plate) yellow red-brown.

Genitalia and associated sterna (Figs 9-13). Gonocoxites broad, gonobase narrow, gonostyli strongly bifid, retrorse lobes well developed, sparsely setose on inner basal margin only; volsellae lightly sclerotised ventroapically; penis valves flanged dorsally, inferior basal process well developed; S7 & S8 weakly sclerotised, both broad, without median process.

Distribution (Fig. 7). Cape York Peninsula and north Queensland.

Etymology. The epithet *albipilatus* means "with white hair" and refers to the colour of the mesosomal and metasomal tomentum.

Discussion

Pachyhalictus albipilatus closely resembles *P. stirlingi* and, although the known distributions are sympatric (Figs 7-8), the two species have not been collected together. (The distribution map of *P. stirlingi* combines locality data listed in Walker (1993) and additional records (Appendix 1) from the "Heathlands" and other expeditions.). Females of *P. albipilatus* may be distinguished from *P. stirlingi* by the white tomentum on the metanotum and terga (bright yellow to pale yellow on *P. stirlingi*) and the presence of three teeth on the inner hind tibial spur (six teeth on *P. stirlingi*). Similar vestiture colour differences allow separation of males. Additional male characters include: *P. albipilatus* S6 with sparsely setose lateral hair tufts and median area with sparse vestiture (Fig. 1), *P. stirlingi* S6 with densely setose lateral hair tufts and median area hairless (Fig. 4); *P. albipilatus* S5 with sparsely setose setal pads and median area with sparse vestiture (Fig. 2), *P. stirlingi* S5 with densely setose setal pads and median area hairless (Fig. 5); *P. albipilatus* S4 with admedian bristle length 1.2 x width of median ocellus and lateral bristle length at least twice (2.1 x) admedian bristle length (Fig. 3), *P. stirlingi* S4 admedian bristle length 1.7 x width of median ocellus and lateral bristle length less than (0.86 x) median bristle length (Fig. 6); and male genitalia of *P. albipilatus* with ventral surface of dorsal gonostyli lobes with median area plicate, basal distal margin without hair and contours of inner proximal margin of gonostyli arms curved (Fig. 13), *P. stirlingi* with median area with area of apically pointed prominences, basal distal margin setose and contours of inner proximal margin of gonostyli arms angulated (Fig. 14). Michener (1978) presented a generic overview of *Pachyhalictus* noting specific exceptions to various character states. The character suite for the two Australian *Pachyhalictus* species complements Michener's character list with the exception that, although male S4 lateral bristles are present, they are substantially reduced and can not be described as 'enormous', as is often found in non-Australian members of the genus.

Acknowledgments

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Appendix 1

Pachyhalictus stirlingi locality data not recorded in Walker (1993).

QUEENSLAND: 1♀, 12 km SSE Heathlands (11°51'S 142°38'E), 26.i-1.iii.1992, P. Feehney, closed forest Malaise #3, #4; 2♂♂, 8 km NW of Bald Hill (13°45'S 143°22'E), McIlwraith Range, 420m, 27.vi-12.vii.1989, I. Naumann, sweeping mango tree site; 1♀, 11 km NW of Bald Hill (13°44'S 143°20'E), McIlwraith Range, 500m, 26.vi-13.vii.1989, I. Naumann, Malaise trap/ethanol; 4♀♀, 15 km NWW of Bald Hill (13°43'S 143°19'E), McIlwraith Range, 420m, 27.vi-12.vii.1989, I. Naumann, weather station site, monsoon-rainforest interface site. (All specimens lodged in ANIC).

BOOK REVIEW

Swallowtail Butterflies of the Americas: A study in Biological dynamics, Ecological diversity, Biosystematics, and Conservation by Hamilton Tyler, Keith S. Brown Jr and Kent Wilson. Scientific Publishers Inc, Gainesville, Florida. 376 pp. 1994.

Readers of *The Australian Entomologist* may be surprised to see a review about American butterflies but the impact of this remarkable book goes far beyond its geographical boundaries. For those interested in the swallowtails of the New World, in particular South America, this book is a must; it contains 100 colour plates of early stages, habitats and adults, including many type specimens of rare and problematical taxa. Yet there is a lot more to this book than just pictures. Indeed, there is something here for everyone interested in almost any aspect of invertebrate biology.

Early chapters discuss the role of swallowtails in nature and culture, their ecology and behaviour and their population biology. As in later chapters, there is a veritable mine of information here, including notes on techniques used in such studies. Chapter 4 discusses the early stages and foodplants, complemented by 32 colour pages depicting virtually all known life histories of American species, plus a key to juveniles. Several detailed descriptions of newly recorded life histories are included and this thorough compilation is one of the major contributions of the book. This is followed by a chapter on host plants and their chemicals, including a detailed list of all hosts recorded. Chapters 6 and 7 discuss mimicry, genetics and hybridization of swallowtails. As in all chapters, absorbing details and do-it-yourself sections provide impetus for further studies. Chapter 8 details the conservation requirements of the fauna, with detailed accounts of the 37 or so endangered taxa. These 3 chapters are enhanced by 16 colour pages.

Biogeography is the subject of chapter 9, with speciation centres discussed and the concept of "biogeographical species" introduced. Descriptions of 11 new subspecies are included. Chapters 10 to 12 discuss systematics, evolution, phylogeny, classification, diversity and biosystematics. As the authors readily agree, these are controversial subjects and these 3 chapters are among the most stimulating of the book. 155 characters, with 225 derived states, are presented and analysed. An interesting aspect of the analysis is the lack of congruence between phylogenies produced using either juvenile or adult characters, and the frequent illogical and improbable associations resulting both from these and combined analyses. Since the characters and interpretations appear sound (with perhaps 1 or 2 exceptions), this suggests that the technique of using computer programs to derive phylogenies is seriously flawed. The ramifications of this are obvious and far-reaching.

The book is rounded off with a key to adults, several appendices and 96 colour pages of adults, depicting virtually every species, subspecies and form likely to be encountered. My only quibble concerns plate 93: the host plant of *Pterourus esperanza* is recorded as *Magnolia dealbata*, whereas the text (page 184) states that this is "probably the host plant", based on the rearing of a single larva, that died before pupation, on the related *M. virginiana*. Since morphological evidence suggests that *P. esperanza* may be a species of *Heraclides*, the host plant may actually be a species of Rutaceae. Everything you ever wanted to know about New World swallowtail butterflies is here in this book, presented in an absorbing and delightfully readable way. Much of the text contains information of use to biologists world-wide and I have no hesitation in recommending it to all those with an interest in the natural world.

D.L. HANCOCK

Dept. of Primary Industries,
Meiers Rd,
Indooroopilly, Qld 4068

OBSERVATIONS ON THE LIFE HISTORY AND HABITS OF THE STAG BEETLE *LAMPRIMA AURATA* (LATREILLE) (COLEOPTERA: LUCANIDAE) IN TASMANIA

Simon Fearn

11 Osberg St, The Gap, Brisbane, Qld 4061

Abstract

Aspects of the life history of *Lamprima aurata* (Latreille) are described, including oviposition, larval and pupal behaviour, larval food sources, adult food plants, feeding behaviour and male territoriality. Characteristics of *L. aurata* populations are discussed, such as size range, sex ratios and factors that may regulate population densities.

Introduction

Lamprima aurata (Latreille) is common and widespread in Tasmania, mainly in the drier eastern half of the State in coastal habitats and dry woodland. In the higher rainfall, densely forested western half of the island, *L. aurata* appears to be a coastal species, with specimens collected by the author as far west as Stanley on the north-west coast. *L. aurata* is recorded also from some of the larger islands of the Furneaux Group, eastern Bass Strait, with specimens in the Queen Victoria Museum, Launceston, from Flinders I. In addition, the author collected a single female on Mt Chappell Is.

Lamprima aurata is common in Victoria and the tablelands of New South Wales (Moore 1986) but scarce in South Australia (Matthews 1984). It is replaced by the closely related *L. latreillii* (Macleay) from coastal New South Wales to north Queensland (Moore 1986). In the author's experience, *L. aurata* does not occur in habitats characterised by closed canopies with wet and/or shaded substrates (temperate rainforests and undisturbed wet sclerophyll forests) or in alpine regions. Areas of human disturbance through forestry or farming activities can be rapidly colonised by *L. aurata* due to the abundance of residual stumps and root systems which provide the larval food source. The following notes describe the behaviour of the various life stages in the Launceston area, from observations made from 1981 to 1990.

Oviposition and larval food sources

Oviposition generally takes place below ground level. Females tunnel into the soil at the bases of stumps, logs and other timber that is partially or wholly buried. C. Spencer (pers. comm.) discovered a female constructing a brood chamber alongside a partially buried eucalypt railroad sleeper. A tunnel 40 mm long and 15 mm wide had been excavated to a depth of 30 mm below soil alongside the sleeper. Three dirty-white eggs, 2 mm x 1 mm in size, had been laid in the 10 mm deep decomposed outer layer of the sleeper. Each egg was deposited in its own small chamber (4 mm x 3 mm) constructed by the female and composed of flakes of decayed wood at the bottom of the tunnel. The female spent 90 mins filling in the tunnel.

The female emerged from the tunnel and, by bracing on its hind and mid legs, loosened soil with the forelegs and mandibles, scraping it backwards into a pile in front of the tunnel entrance. When enough soil had been gathered, the female pushed the earth forwards into the tunnel, remaining underground for 2 mins at a time before emerging to repeat the process. When the tunnel was full the female remained motionless on the ground for several minutes before flying away.

Oviposition above ground level is rare, with only three examples known to the author. One female was observed to tunnel into the side of a large stump of *Acacia dealbata* Link. It alighted on the stump 0.4 m above the ground and located a crack in the hard bark and outer wood. The interior of the stump consisted of soft, pulpy wood which the beetle penetrated, using its forelegs. On another occasion, 24 adults were collected from pupal chambers in a dead black wattle *Acacia mearnsii* De Wild. in dry scrubland. The diameter of the tree trunk was 0.4 m and it had come to rest 0.6 m above the ground after being blown over. Infestation had taken place in the soft, pulpy interior. In the third example, larval infestation was discovered in dry eucalypt forest in a large eucalypt (trunk diameter 1.05 m) that had blown over. Larval galleries were situated in a thin layer of white, pulpy wood, 30 mm deep, immediately beneath the bark. In the latter two examples, oviposition and subsequent larval infestation had taken place in the log itself and not via the roots of the fallen trees.

Dead and decaying tree root systems are the major larval food source of *L. aurata* in Tasmania, with both native and ornamental species infested. The author has found larvae in the dead root systems of *Acacia*, *Banksia*, *Eucalyptus*, *Populus*, *Salix* and *Virgilia*, plus *Pinus radiata*. Larvae and adults (within pupal chambers) have been collected from buried wooden framing around house foundations, fence posts, telegraph poles, logs partially buried in soil and sawdust heaps in abandoned rural sawmills.

Larval behaviour and pupation

Larvae hatching from eggs deposited at the base or underside of stumps appear to bore outwards along the underside of major roots, usually to a distance of 1-1.5 m by the time the pupal chamber is constructed, depending on the length and diameter of the root. Sometimes, if thick bark is still present on the stump, larvae will bore upwards from below soil level, pupating under the bark 15-30 cm above ground.

Larvae which develop in fence posts and telegraph poles bore either around the perimeter of the wood or up or down, depending on the length of timber below ground level. Larvae bore in a more or less straight line, packing the tunnel behind them with faecal material and wood scrapings.

The last larval instar, 30-35 mm long, begins to construct a pupal chamber in September. This is an oval cell, 20-30 mm long, chewed out of the

wood. In most cases the chamber is constructed just beneath the outer surface of the root, with a thin layer of wood covering it to facilitate adult emergence. Both ends are padded with tightly packed strips of wood, 4-15 mm long. The other most common type of pupal chamber (usually on thin roots) is constructed on the outer surface of a root and is built partially out into the soil. In this case, one wall of the chamber is the root and the other is constructed entirely from strips of wood.

Construction of the pupal chamber and duration of the prepupal and pupal stages appears to take several months as fully hardened and coloured adults are not found in pupal chambers until late February or April. While one generation of adults is dying, those of the next generation are fully formed within pupal chambers, where they remain for 9-10 months until the following summer.

The time taken to develop from the late instar larva to adult emergence is at least 2 years, so the entire cycle from egg to emerging adult may take at least 3 years in Tasmania.

Adult emergence, food plants and feeding behaviour

During the course of this study, emergence of *L. aurata* adults took place consistently in the first 2 weeks of December each year and appeared to be initiated by temperature. Emergence took place on hot, windless days, with both sexes emerging in late morning between approximately 10.30 and noon. Adults tunnel out of the pupal chamber and up through the soil, scrambling around for a few minutes before flying away. No attempts at copulation were observed on the ground before flight.

The most favoured adult food trees in Tasmania are *Eucalyptus viminalis* Labill., *E. globulus* Labill. and *E. pauciflora* Sieb. ex Spreng. Six females and 13 males were collected feeding on a large clump of *Lomandra longifolia* Labill. on the east coast of Tasmania. Mating pairs have been collected on blossom of *Leptospermum* and *Hakea teretifolia* (Salis) J. Britt. One male was observed feeding on an overripe strawberry in Launceston and adults found feeding on an ornamental *Photina* sp.

Adults feed on the last 50-100 mm of the uppermost shoots on host trees, males cutting them off at about 3 mm diameter. The mandibles of females are small and weak and they appear to rely on males to open up the food resource; they have not been observed cutting the shoots. At the end of the cut stem single males or mating pairs feed on the exudates of phloem and xylem. Most trees suffer no serious damage from this feeding, but some that are heavily infested for several years begin to take on a box shape from the annual tip pruning.

Young trees, 2-10 m in height appear to be preferred to large mature trees and of these only certain trees appear to be selected. In December 1982-83, over 400 adults were collected on 6 saplings of *Eucalyptus viminalis* in

approximately 2 ha of open *Acacia* and *Eucalyptus* scrub in Trevallyn, Launceston. Many other saplings of *E. viminalis* were present but in both years only the same 6 trees were used. By the summer of 1984 two of these trees had been cut down and only 2 of the remaining 4 continued to attract beetles between 1984 and 1990. No obvious differences were discernible between favoured and non-favoured trees.

In 1977 and 1985, a *Photina* sp. tree in a Launceston garden was visited by dozens of *L. aurata* but not in intervening years, although adults were common and present each year on nearby specimens of *E. globulus*. These suggest that *L. aurata* may be able to detect physiological differences in trees that make them more attractive as a food source.

Monteith (1992) described similar behaviour in the dynastid *Xylotrupes gideon* L., feeding on poinciana trees (*Delonix regia*) in Brisbane, Queensland. Particular trees became very attractive to the beetles, with large numbers congregating to feed on the bark of young shoots. Norris (1991) noted many examples of insect resistant plants within a given species but the reasons for resistance are not readily discernible.

Copulation and territorial behaviour

Adult male *L. aurata* are territorial and once alighted on a suitable shoot they defend it vigorously, attacking other males with their large mandibles. These contests normally last less than a minute, with the larger male winning. On several occasions, large males lifted a smaller one from a twig by a leg and threw it off. More often, the weaker male retreats backwards down the stem to try elsewhere. In heavily infested trees these contests result in a large number of defeated males falling to the ground.

Copulation occurs at the cut shoot tips. Females are rarely seen without an attendant male and their apparent inability to sever shoots indicates that females may be attracted to cut shoot tips provided by the males, further indicated by the vigorous defence of cut shoot tips by males.

Size range and sex ratio

Adult Tasmanian *L. aurata* vary considerably in size, particularly males. Most males are 21-28 mm long, the largest examined being 34 mm long (including mandibles) and 14 mm wide, the smallest 15 mm x 6 mm. Most females are 19-22 mm long, the largest examined being 25 mm long x 10 mm wide, the smallest 14 mm long.

There is little variation in relative size of mandibles in males, remaining in proportion to body size. This may be due to the functional role played by the mandibles in cutting shoot tips and defending them.

In field collected samples, males outnumbered females by approximately 3 to 1 (Table 1).

Table 1. Numbers of males and females in samples of *L. aurata*.

DATE	LOCATION	MALES	FEMALES	TOTAL
14.xii.1982	Trevallyn, Launceston	172	60	232
23.xii.1982	Beechford, North coast	25	7	32
18.xii.1983	Trevallyn, Launceston	170	50	220
27.i.1984	Greens Beach, North coast	50	28	78
1.i.1985	Beechford, North coast	36	9	45
13.i.1985	Greens Beach, North coast	26	19	45
26.i.1986	Chain of Lagoons coastal reserve, East coast	31	4	35
TOTALS		510	177	687

Population densities

Lamprima aurata appears to be a species that thrives through human alteration of habitats. Of hundreds of larval food sources examined, all but two resulted from human activity. It is likely that the abundance and distribution of *L. aurata* in Tasmania has increased since the arrival of Europeans. From the author's observations, it is apparent that *L. aurata* prefers well drained sites with maximum exposure to solar radiation., particularly in relation to larval food resources. No evidence of this species has been found in undisturbed closed forest and in cooler, higher rainfall districts it appears to be confined to areas disturbed by forestry or farming activity.

Forestry activities have been extensive in Tasmania for many years and clear fell operations in particular provide abundant larval food resources through stumps, logs and other timber that are left behind. This is enhanced in some cases by the replanting of eucalypt species attractive to the adults. In forestry plantations where conditions were ideal for *L. aurata* (abundant residual timber), thousands of adults were active in the young trees. Any land clearing that does not include removal of stumps and logs provides an opportunity for colonisation by *L. aurata*.

In some areas *L. aurata* does not become established in large numbers despite the presence of apparently suitable larval food sources. This may be due to an absence of suitable adult food trees, implying that adults do not fly far either in search of suitable food trees after emergence or for suitable oviposition sites after mating.

In addition to land clearance, timber in service, such as fence posts and untreated telegraph poles throughout rural and urban areas, have been utilised by *L. aurata*. High fire frequencies around towns and coastal shack developments also provide abundant residual timber and root systems.

Larval food resources in any given area appear to be a major factor governing population density. In December of 1982 and 1983, over 450 specimens of

L. aurata were collected and many more observed, in an area of open scrub and grazing land at Trevallyn, Launceston, where high voltage electric towers are located and trees (mainly *Acacia mearnsii*) below and around the towers were poisoned. Dead stumps and root systems provided an abundant larval food source. Peak years for *L. aurata* in this area were 1982 and 1983; between 1984 and 1990, no more than 20-40 adults were observed each season and their average size also decreased. This decline in number and size appears to be a result of the near exhaustion of the larval food source. Excavated root systems and lower trunks of the dead trees and stumps were composed mainly of frass, with little or no intact wood. Larval resource limitations therefore may cause populations of *L. aurata* to fluctuate widely over time and space.

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A NOTE ON THE IDENTITY OF MALE
EURYGLOSSINA (TURNERELLA) BICOLOR (RAYMENT)
(HYMENOPTERA: COLLETIDAE: EURYGLOSSINAE)

Elizabeth M. Exley

Department of Entomology, University of Queensland, St Lucia, Qld 4072

Abstract

The sexes of *Euryglossina (Turnerella) bicolor* (Rayment) are associated.

I was asked recently to identify some rather badly preserved insects in the collection of the Forestry Commission of New South Wales. All were labelled 'Kirribilli, N.S.W., ii.1957, Payne, ex *Anobium* workings' and were bees of the family Colletidae, subfamily Euryglossinae.

The 14 females present proved to be *Euryglossina (Turnerella) bicolor* (Rayment) and the three males were identical to those described under 'unassociated males' as *Euryglossina (Turnerella)* sp. N in Exley (1968: 1009-1011). At the time of that revision, sp. N males were known only from an area of southeast Queensland around Brisbane, whereas *E. bicolor*, known only from females, had been collected in Victoria and New South Wales as well as around Brisbane, with a further three specimens known from Kuranda in north Queensland. Species of *Euryglossina* Cockerell may exhibit strong sexual dimorphism, hence there are problems encountered in associating the sexes.

Of the 73 specimens originally recorded as sp. N, 65 bear labels identical to those on 66 *E. bicolor* females. I am satisfied that the bee described as *Euryglossina (Turnerella)* sp. N is the male of *E. (T.) bicolor*.

Biological knowledge of the genus *Euryglossina* remains scanty and it is of interest that the seven females recorded from Mosman (Exley 1968: 987) were also in beetle-infested timber.

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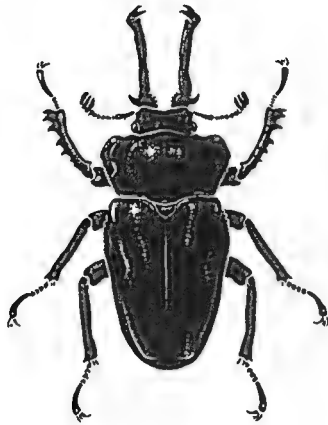
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